

# **EXHIBIT 32**



**Sam Abuelsamid** Contributor

*A lifetime in the car business, first engineering, now communicating*

Opinions expressed by Forbes Contributors are their own.

**AUTOS** 1/08/2017 @ 4:30PM | 15,144 views

## Google Spin-off Waymo Set To Become Full-Fledged Automated Driving Provider



Waymo Self-Driving Chrysler Pacifica Hybrid ( photo credit: Fiat Chrysler Automobiles)

As a stand-alone company Waymo has only existed for about a month since being spun off from Alphabet Inc.'s X lab. Despite that, Waymo has the potential to be one of the most important players in the future of the auto industry in the coming years. At the Automobili-D conference running in conjunction with the North American International Auto Show in Detroit, Waymo CEO John Krafcik announced that the company has designed and built its own complete sensor suite, processing system and software in order to produce a fully automated driver stack.

“Our goal is to build a better driver,” said Krafcik. “An automated driver.”

The fleet of Chrysler Pacifica hybrids revealed in December are the first vehicles equipped with Waymo’s dedicated sensor suite. All of the sensors on these vehicles have been completely engineered and manufactured in-house by Waymo and specifically optimized for a fully-autonomous driving application.

“We have to build our own self-driving hardware and software,” added Krafcik.

**GET 20% OFF**

identity theft protection from LifeLock when you pay with PayPal. Use promo code **PAYPAL16**.<sup>\*</sup> Terms Apply.

[Join Now](#)

Like most companies developing automated driving systems, Waymo relies heavily on LiDAR sensors to scan the world around the car. Previous generations of Waymo's test vehicles have used a medium range LiDAR sensor. The Pacifica now has three types of LiDAR that operate at short, medium and long ranges, all designed by Waymo. This enables the vehicle to see both further down the road and in the immediate vicinity around the car. Equally important is the cost of the sensors. Waymo claims to have slashed the cost by 90% from the first off-the-shelf sensors it used which cost more than \$75,000. More importantly, Waymo has learned from the 2 million test miles it has accumulated and designed its sensors to be more robust to the vibration and temperature challenges faced in the automotive environment.



Waymo CEO introduces the self-driving Chrysler Pacifica Hybrid with an in-house built hardware and software suite. (photo credit: Sam Abuelsamid)

Similarly, Waymo has developed its own radar and vision sensors. The system on the Pacifica features eight of its enhanced camera modules that have been specifically designed to handle the often difficult lighting conditions that human drivers have to deal with on a daily basis. This is exactly the sort of situation that contributed to the deadly crash of a Tesla Model S in May 2016. The off-the-shelf Mobileye vision system used in that vehicle was unable to detect a white truck against a bright sky as it turned left across the path of the car while it operated under semi-autonomous control.

An additional high-resolution forward-looking multi-sensor module is designed to be able to detect smaller objects like traffic cones at longer distances. Similarly the radar sensors have been optimized for the automated driving environment, providing a 360 degree field of view and the ability to detect slower moving objects like pedestrians and cyclists. Traditional automotive radar sensors have a relatively narrow field of view and optimized for detecting vehicles in applications like adaptive cruise control. In combination with the vision and LiDAR sensors, the radar helps augment situational awareness in poor weather conditions.

Blending all of this real-time data requires some serious processing power and software smarts. Waymo has put together its own high-power computing system to handle its AI and machine learning capabilities on the fly. Few companies in the world have the artificial intelligence capabilities of Google and



Waymo and this knowledge has been incorporated into a full stack that perceives the world around the car and controls its navigation through it.

To date, Waymo has accumulated more than 2.5 million miles of automated driving in California and Arizona and expects to top 3 million by May 2017 as its fleet of Pacificas join the test program. An indicator of the progress that Waymo has made can be found in the disengagement reports that companies testing autonomous cars in California must file every month. These reports are part of the testing regulations there and likely played a part in Uber's recent refusal to sign up for a testing permit. Companies must report total miles driven autonomously and how many times the system disengaged.

From September 2014 through December 2015, the number of miles that Waymo vehicles went between disengagements where a human driver had to take over went from 785 to 5318. Through 2016, the rate of disengagements of the system dropped from 0.8 per 1,000 miles to just 0.2. For comparison in that same 15 month period in 2014 to 2015, Nissan only accumulated 1,485 miles of autonomous driving on public roads and had 106 disengagements. Delphi had 405 disengagements in less than 17,000 miles of testing. Clearly, Waymo is well on its way to creating a very reliable system, at least in warm weather states. With the deployment of the Pacifica fleet, the test environment will be expanding to integrate more weather conditions.

So with all of this hardware and software, what does Waymo plan to do with it? They aren't saying specifically yet, but they don't intend to become a traditional automotive supplier. They understand the need to be responsible for the full stack of automated driving capability to ensure it works properly. That means it's unlikely that they will sell their package to existing automakers to include on the vehicles.

Instead we are more likely to see Waymo strike deals like the one they did with FCA for the Pacificas. FCA sold a batch of vehicles to Waymo and worked with them to integrate the self-driving stack into the electrical architecture. From there, Waymo has taken full control of the vehicles and the testing regime. As the technology becomes commercialized, it's unlikely that Waymo will get into building complete vehicles but will instead contract with a manufacturer to build a bespoke platform optimized for autonomous mobility applications.

What sort of applications might those be? Again Waymo isn't giving specifics yet, but sources have indicated that a number of potential models may part of a larger mobility ecosystem. This could include the sort of on-demand ride-hailing offered by Uber and Lyft today, subscription services like the recently announced Book service from Cadillac or car-sharing services. More information on Waymo's direction is promised soon.

With all of this, Waymo looks positioned to potentially be a major player in our transportation future even if they don't become an automaker.

*The author is a senior analyst on the Transportation Efficiencies team at [Navigant Research](#) and co-host of the [Wheel Bearings](#) podcast*

**RECOMMENDED BY FORBES**

[Google's Waymo...Is Waymo Than Just the Car](#)

[Honda Is The Latest Carmaker To Work With Alphabet's Waymo On Self-Driving...](#)

[The Much-Maligned Minivan Is The Perfect Vehicle To Usher In The Era Of Self-Driving...](#)

[Google Spins Off Self-Driving Car Unit As 'Waymo'](#)

[The Richest Person In Every State](#)

[Ten Things That Are Worse For Your Career Than Getting Fired](#)

[The Toughest Jobs To Fill In 2017](#)

[Stan Lee Introduces Augmented Reality For His Kids Universe](#)

---

This article is available online at:

2017 Forbes.com LLC™ All Rights Reserved